Shelby County Schools Science Vision

Shelby County Schools' vision of science education is to ensure that from early childhood to the end of the 12th grade, all students have heightened curiosity and an increased wonder of science; possess sufficient knowledge of science and engineering to engage in discussions; are able to learn and apply scientific and technological information in their everyday lives; and have the skills such as critical thinking, problem solving, and communication to enter careers of their choice, while having access to connections to science, engineering, and technology.

To achieve this, Shelby County Schools has employed The Tennessee Academic Standards for Science to craft meaningful curricula that is innovative and provide a myriad of learning opportunities that extend beyond mastery of basic scientific principles.

Introduction

In 2014, the Shelby County Schools Board of Education adopted a set of ambitious, yet attainable goals for school and student performance. The District is committed to these goals, as further described in our strategic plan, Destination 2025. In order to achieve these ambitious goals, we must collectively work to provide our students with high quality standards aligned instruction. The Tennessee Academic Standards for Science provide a common set of expectations for what students will know and be able to do at the end of each grade, can be located in the Tennessee Science Standards Reference. Tennessee Academic Standards for Science are rooted in the knowledge and skills that students need to succeed in post-secondary study or careers. While the academic standards establish desired learning outcomes, the curricula provides instructional planning designed to help students reach these outcomes. The curriculum maps contain components to ensure that instruction focuses students toward college and career readiness. Educators will use this guide and the standards as a roadmap for curriculum and instruction. The sequence of learning is strategically positioned so that necessary foundational skills are spiraled in order to facilitate student mastery of the standards.

Our collective goal is to ensure our students graduate ready for college and career. Being College and Career Ready entails, many aspects of teaching and learning. We want our students to apply their scientific learning in the classroom and beyond. These valuable experiences include students being facilitators of their own learning through problem solving and thinking critically. The Science and Engineering Practices are valuable tools used by students to engage in understanding how scientific knowledge develops.These practices rest on important "processes and proficiencies" with longstanding importance in science education. The science maps contain components to ensure that instruction focuses students toward understanding how science and engineering can contribute to meeting many of the major challenges that confront society today. The maps are centered around five basic components: the Tennessee Academic Standards for Science, Science and Engineering Practices, Disciplinary Core Ideas, Crosscutting Concepts, and Phenomena.

The Tennessee Academic Standards for Science were developed using the National Research Council's 2012 publication, A Framework for K-12 Science Education as their foundation. The framework presents a new model for science instruction that is a stark contrast to what has come to be the norm in science classrooms. Thinking about science had become memorizing concepts and solving mathematical formulae. Practicing science had become prescribed lab situations with predetermined outcomes. The framework proposes a three-dimensional approach to science education that capitalizes on a child's natural curiosity. The Science Framework for K-12 Science Education provides the blueprint for developing the effective science practices. The *Framework* expresses a vision in science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The *Framework* identified a small number of disciplinary core ideas that all students should learn with increasing depth and sophistication, from Kindergarten through grade twelve. Key to the vision expressed in the *Framework* is for students to learn these disciplinary core ideas in the context of science and engineering practices. The importance of combining Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas is stated in the *Framework* as follows:

Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content. (NRC Framework, 2012, p. 218)

To develop the skills and dispositions to use scientific and engineering practices needed to further their learning and to solve problems, students need to experience instruction in which they use multiple practices in developing a particular core idea and apply each practice in the context of multiple core ideas. We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Students in grades K-12 should engage in all eight practices over each grade band. Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas. There are seven crosscutting concepts that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas and develop a coherent and scientifically based view of the world.

The map is meant to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional practice. In fact, our goal is not to merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. Teachers who are knowledgeable about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are best-positioned to make decisions about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, leaders, and other support providers--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related best practices. However, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning are non-negotiable. We must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful support of literacy and language learning across the content areas.

Science and Engineering Practices

1. Asking questions & defining problems
2. Developing & using models
3. Planning & carrying out investigations
4. Analyzing & interpreting data
5. Using mathematics & computational thinking
6. Constructing explanations & designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, & communicating information

Disciplinary Core Ideas

Physical Science
PS 1: Matter & its interactions
PS 2: Motion & stability: Forces & interactions
PS 3: Energy
PS 4: Waves & their applications in technologies for information transfer

Life Sciences
LS 1: From molecules to organisms: structures & processes
LS 2: Ecosystems: Interactions, energy, & dynamics
LS 3: Heredity: Inheritance & variation of traits
LS 4: Biological evaluation: Unity & diversity

Earth & Space Sciences
ESS 1: Earth's place in the universe
ESS 2: Earth's systems
ESS 3: Earth & human activity

Engineering, Technology, & the Application of Science
ETS 1: Engineering design
ETS 2: Links among engineering, technology, science, & society

Crosscutting Concepts

1. Patterns
2. Cause & effect
3. Scale, proportion, & quantity
4. Systems & system models
5. Energy & matter
6. Structure & function
7. Stability & change

Learning Progression

At the end of the elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ideas into broad concepts first by single properties and later by multiple properties. They can create and interpret graphs and models that explain phenomena. Students can keep notebooks to record sequential observations and identify simple patterns. They are able to design and conduct investigations, analyze results, and communicate the results to others. Students will carry their curiosity, interest and enjoyment of the scientific world view, scientific inquiry, and the scientific enterprise into middle school.

At the end of the middle school science experience, students can discover relationships by making observations and by the systematic gathering of data. They can identify relevant evidence and valid arguments. Their focus has shifted from the general to the specific and from the simple to the complex. They use scientific information to make wise decision related to conservation of the natural world. They recognize that there are both negative and positive implications to new technologies.

As an SCS graduate, former students should be literate in science, understand key science ideas, aware that science and technology are interdependent human enterprises with strengths and limitations, familiar with the natural world and recognizes both its diversity and unity, and able to apply scientific knowledge and ways of thinking for individual and social purposes.

Structure of the Standards

- Grade Level/Course Overview: An overview that describes that specific content and themes for each grade level or high school course.
- Disciplinary Core Idea: Scientific and foundational ideas that permeate all grades and connect common themes that bridge scientific disciplines.
- Standard: Statements of what students can do to demonstrate knowledge of the conceptual understanding. Each performance indicator includes a specific science and engineering practice paired with the content knowledge and skills that students should demonstrate to meet the grade level or high school course standards.

Purpose of Science Curriculum Maps

This map is a guide to help teachers and their support providers (e.g., coaches, leaders) on their path to effective, college and career ready (CCR) aligned instruction and our pursuit of Destination 2025. It is a resource for organizing instruction around the Tennessee Academic Standards for Science, which define what to teach and what students need to learn at each grade level. The map is designed to reinforce the grade/course-specific standards and content (scope) and provides *suggested* sequencing, pacing, time frames, and aligned resources. Our hope is that by curating and organizing a variety of standards-aligned resources, teachers will be able to spend less time wondering what to teach and searching for quality materials (though they may both select from and/or supplement those included here) and have more time to plan, teach, assess, and reflect with colleagues to continuously improve practice and best meet the needs of their students.

The map is meant to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional practice. In fact, our goal is not to merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. Teachers who are knowledgeable about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are best-positioned to make decisions about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, leaders, and other support providers--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related best practices. However, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning are non-negotiable. We must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful support of literacy and language learning across the content areas.

[Quarter 1 Curriculum Map Survey]

6th Grade Quarter 1 Curriculum Map

Unit 1 Energy	Unit 2 Relationships Among Organisms	Unit 3 Earth's Biomes and Ecosystems	Unit 4 Earth's Resources and Human Impact on the Environment	Unit 5 Earth's Water	Unit 6 Earth's Systems	Unit 7 Weather and Climate
9 weeks	3 weeks	6 weeks	3 weeks	3 weeks	3 weeks	9 weeks
Quarter 1	Quarter 2		Quarter 3			Quarter 4

UNIT 1: Energy (9 weeks)

Overarching Question(s)

How is energy transferred and conserved?

Unit 1, Lesson 1	Lesson Length	Essential Question	Vocabulary
Introduction to Energy	2.5 weeks	What is energy?	energy, kinetic energy, potential energy, energy transformation, law of conservation of energy

Standards and Related Background Information	Instructional Focus	Instructional Materials
DCI(s) PS3: Energy **Standard(s)** 6.PS3.1 Analyze the properties and compare the sources of kinetic, elastic potential, gravitational potential, electric potential, chemical, and thermal energy. 6.PS3.2 Construct a scientific explanation of the transformation between potential and kinetic energy.	**Learning Outcomes** • Compare kinetic and potential energy. • Classify an object's energy as either kinetic energy, potential energy, or both. • Describe mechanical energy. • Describe different forms of energy. • Describe examples of different forms of energy. • Describe the Law of Conservation of Energy being converted from one form to another.	**Curricular Materials** HMH Tennessee Science TE, pp. 10-23 Engage and Explore • Engage Your Brain #s 1 and 2, SE p. 5 • Active Reading #s 3 and 4, SE p. 5 Explain Kinetic and Potential Energy • Active Reading #5, SE p. 6 • Think Outside the Book #6, SE p. 7 • Analyze #7, SE p. 7 • Setting Objects in Motion Quick Lab, TE p. 13 (SEP: Planning and Carrying Out Controlled Investigations)

Explanation(s)	Phenomenon	
<u>6.PS3.1</u> Students should develop an understanding of energy which has two components: energy storage (6.PS3.1) and transformation (6.PS3.2). Energy can be possessed by an object or stored in fields. Objects can possess energy as kinetic (motion of objects), thermal (motion of particles), or chemical energy (energy stored in chemical bonds). Fields can possess energy based on the position of an object within the field. Gravitational fields store/release gravitational potential energy when an object changes position within the gravitational field. Electric fields store/release electric potential energy as charges change position within an electric field. Finally, forces which distort the shapes of objects store energy in the elastic/distorted object (elastic potential). For example, the elastic bands of a sling shot store energy when they are pulled back. Upon release, the elastic bands then do work on the object in the slingshot transferring energy away from the bands and giving kinetic energy to the projectile. <u>6.PS3.2</u> Students are first exposed to potential energy in fourth grade, but at that time students were not expected to classify types of energy. Students should develop an understanding of energy which has two components: energy storage (6.PS3.1) and transformation (6.PS3.2). Transfer of energy can move the energy from one energy type	 Click on the picture to show the fireworks explosion. The solid chemicals packed into the cardboard case don't simply rearrange themselves into other chemicals: some of the chemical energy locked inside them is converted into four other kinds of energy (heat, light, sound, and the kinetic energy of movement).	• Bungee Jumping Quick Lab, TE p. 13 • Designing a Simple Device S.T.E.M. Lab, TE p. 13 (SEP: Constructing Explanations and Designing Solutions, Analyzing and Interpreting Data) Forms of Energy • Visualize It! #8, SE p. 8 • Compare #9, SE p. 9 • Infer #10, SE p. 9 • Active Reading #11, SE p. 10 • Synthesize #12, SE p. 10 The Law of Conservation of Energy • Visualize It! #16, SE p. 12 • Active Reading #17, SE p. 13 • Think Outside the Book #18, SE p. 13 • Describe #19, SE p. 13 • Diagramming Mechanical Energy Activity, TE p. 12 • Conservation of Energy Quick Lab, TE p. 13 (SEP: Using Mathematics and Computational Thinking) <u>Extend</u> Reinforce and Review • The Law of Conservation of Energy Process Chart, TE p. 16 • Visual Summary, SE p. 14 Going Further • Fine Arts Connection, TE p. 16 • Space Science Connection, TE p. 16

to a different energy type. (Types of energy are included in 6.PS3.1) The methods of energy transfer include work, heat, and radiation. For example: If fired upwards, a projectile slows down as it ascends, doing work on Earth's gravitational field and storing gravitational potential energy in the field. Ultimately it stops at a maximum height. For this moment of rest, the object possesses no energy. Earth's gravitational field can then do work on the object speeding it up as it then descends and returning energy to the projectile as kinetic energy while the object returns to the ground. (A focus should be placed on examples in which work is the means of energy transfer.) **Misconception(s)** Explain that energy is defined as the ability or capacity to do work or to produce change. The composition of an object and its position determines what kind of energy it has. Living things are unique in that they can convert chemical energy in food to another form, for example, thermal energy. energy is in everything. Students may confuse energy conservation with the conversion of energy. Explain that the conservation of energy refers to a law of physics that states that energy can neither be created or nor destroyed; it can only change from one form to another, meaning that when energy is "lost" in a		• Why It Matters, SE p. 11 Evaluate Formative Assessment • Throughout TE • Lesson Review, SE p. 15 Summative Assessment • Energy Alternative Assessment, TE p. 17 • Lesson Quiz **Additional Resources** • Energy of Motion Curricular Unit • Energy cK12 Article • 6.PS3.2 Student Activity and Teacher Guide

conversion, it simply exists in a different form. Tell students that energy conservation refers to the practice of using less energy to conserve environmental resources. **Suggested Science and Engineering Practice(s)** Developing and Using Models 6.PS3.1 Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models. Constructing Explanations and Designing Solutions 6.PS3.2 Students form explanations using sources (including student developed investigations) which show comprehension of parsimony, utilize quantitative and qualitative models to make predictions, and support or cause revisions of a particular conclusion. **Suggested Crosscutting Concept(s)** Energy and Matter 6.PS3.1, 6.PS3.2 Students track energy changes through transformations in a system.		

UNIT 1: Energy (9 weeks)			
Overarching Question(s)			
How is energy transferred and conserved?			
Unit 1, Lesson 2	**Lesson Length**	**Essential Question**	**Vocabulary**
Kinetic and Potential Energy	2.5 weeks	How can we calculate kinetic and potential energy?	potential energy, kinetic energy, mechanical energy

Standards and Related Background Information	Instructional Focus	Instructional Materials
DCI(s) PS3: Energy **Standard(s)** 6.PS3.1 Analyze the properties and compare the sources of kinetic, elastic potential, gravitational potential, electric potential, chemical, and thermal energy. 6.PS3.2 Construct a scientific explanation of the transformation between potential and kinetic energy. 6.PS3.3 Analyze and interpret data to show the relationship between kinetic energy and the mass of an object and its speed. **Explanation(s)** 6.PS3.1 Students should develop an understanding of energy which has two components: energy storage (6.PS3.1) and transformation (6.ps3.2). Energy can be possessed by an object or stored in	**Learning Outcomes** • Describe/explain examples of kinetic energy. • Calculate an object's kinetic energy given its mass and speed. • Describe/explain examples of potential energy. • Calculate an object's gravitational potential energy given its mass and its height from the ground. • Calculate an object's mechanical energy, given kinetic or potential energy of the object. **Phenomenon**  Potential energy and kinetic energy are the reason trampolines allow you to jump higher than you can on flat ground. One type of potential energy that is involved with trampolines is the elastic potential energy stored in springs. Another type of energy is gravitational potential energy. This can be described under the big	**Curricular Materials** HMH Tennessee Science TE, pp. 24-36 Engage and Explore • Engage Your Brain #s 1 and 2, SE p. 19 • Active Reading #3, SE p. 19 Explain Kinetic Energy • Active Reading #5, SE p. 20 • Visualize It! #6, SE p. 20 • Do the Math #7, SE p. • Identify Potential and Kinetic Energy Quick Lab, TE p. 27 (SEP: Analyzing and interpreting data, Obtaining, evaluating, and communicating information) • Energy of a Tennis Ball Activity, TE p. 26 • Kinetic Energy Virtual Lab, TE p. 27 Potential Energy • Think Outside the Book #8, SE p. 22 • Visualize It! #9, SE p. 22

fields. Objects can possess energy as kinetic (motion of objects), thermal (motion of particles), or chemical energy (energy stored in chemical bonds). Fields can possess energy based on the position of an object within the field. Gravitational fields store/release gravitational potential energy when an object changes position within the gravitational field. Electric fields store/release electric potential energy as charges change position within an electric field. Finally, forces which distort the shapes of objects store energy in the elastic/distorted object (elastic potential). For example, the elastic bands of a sling shot store energy when they are pulled back. Upon release, the elastic bands then do work on the object in the slingshot transferring energy away from the bands and giving kinetic energy to the projectile. <u>6.PS3.2</u> Students are first exposed to potential energy in fourth grade, but at that time students were not expected to classify types of energy. Students should develop an understanding of energy which has two components: energy storage (6.PS3.1) and transformation (6.PS3.2). Transfer of energy can move the energy from one energy type to a different energy type. (Types of energy are included in 6.PS3.1) The methods of energy transfer include work, heat, and radiation. For example: If fired upwards, a projectile slows down as it ascends, doing work on Earth's gravitational	umbrella of kinetic energy because of the people being motion. Click on the image to view the video clip.	• Investigate Potential Energy Quick Lab, TE p. 27 (SEP: Planning and carrying out controlled investigations, Analyzing and interpreting data) • Do the Math #10, SE p. 23 Mechanical Energy • Roller Coaster Ride Daily Demo, TE p. 27 • Active Reading #11, SE p. 24 • Visualize It! #12, SE p. 24 • Analyze #13, SE p. 24 • Do the Math #14, SE p. 25 • Graph #15, SE p. 25 • Analyze #16, SE p. 25 • Mechanical Energy Exploration Lab, TE p. 27 (SEP: Analyzing and Interpreting Data, Planning and Carrying out Controlled Investigations) <u>Extend</u> Reinforce and Review • Word Triangles Graphic Organizer, TE p. 30 • Visual Summary, SE p.26 Going Further • Physical Education Connection, TE p. 30 • Real-World Connection, TE p. 30 <u>Evaluate</u> Formative Assessment • Throughout TE • Lesson Review, SE p. 27 Summative Assessment • Kinetic and Potential Energy Alternative Assessment, TE p. 31

field and storing gravitational potential energy in the field. Ultimately it stops at a maximum height. For this moment of rest, the object possesses no energy. Earth's gravitational field can then do work on the object speeding it up as it then descends and returning energy to the projectile as kinetic energy while the object returns to the ground. (A focus should be placed on examples in which work is the means of energy transfer.) 6.PS3.3 Students should analyze data to see that kinetic energy is directly proportional to mass and to the square of velocity. Students can be provided data to carry out this analysis. Alternately, heavy objects can be dropped into beds of flour or soft material and comparisons of the indentions can be made. Doubling the mass and dropping from the same height will produce an indention with a volume twice as great. Dropping an object from a height twice as great leaves and indention with four times the volume. (Instruction of this standard can be limited to recognizing that as the speed of an object increases, the kinetic energy increases at a greater rate and describing qualitative changes to kinetic energy. Creating proportionalities, graphing linear/quadratic relationships and exponents all exceed sixth grade Tennessee math standards, but can be used for enrichment in with advanced students.)		• Lesson Quiz **Additional Resources** • Energy & Matter STUDY JAMS! Video • TeachEngineering: Physics of Roller Coasters • TeachEngineering: Exploring Energy: What is Energy? • 6.PS3.3 Student Activity and Teacher Guide

Misconception(s) Students may need to be reminded that energy is a property of an object that can be measured. It can change from one form to another, but the total quantity of energy is always conserved in these changes. Students will need to understand that energy can change from potential energy to kinetic energy and back to potential energy. Remind them that energy is not created when these changes occur, and that energy is not destroyed, or "lost" during these changes. **Suggested Science and Engineering Practice(s)** <u>Developing and Using Models</u> 6.PS3.1 Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models. <u>Constructing Explanations and Designing Solutions</u> 6.PS3.2 Students form explanations using source (including student developed investigations) which show comprehension of parsimony, utilize quantitative and qualitative models to make predictions, and support or cause revisions of a particular conclusion. <u>Analyzing and Interpreting Data</u> 6.PS3.3		

Students should create and analyze graphical presentations of data to identify linear and non-linear relationships, consider statistical features within data and evaluate multiple data sets for a single phenomenon. **Suggested Crosscutting Concept(s)** Energy and Matter 6.PS3.1, 6.PS3.2 Students track energy changes through transformations in a system. Scale, Proportion, and Quantity 6.PS3.3 Students create proportional and algebraic relationships from graphical representations.		

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<tr><th colspan="4">UNIT 1: Energy (9 weeks)</th></tr>
<tr><th colspan="4">Overarching Question(s)</th></tr>
<tr><td colspan="4">How is energy transferred and conserved?</td></tr>
<tr><th>Unit 1, Lesson 3</th><th>Lesson Length</th><th>Essential Question</th><th>Vocabulary</th></tr>
<tr><td>Thermal Energy and Heat</td><td>2.5 weeks</td><td>What is the relationship between heat and temperature?</td><td>thermal energy, heat, conduction, conductor, insulator, calorie, convection, radiation, temperature, degrees</td></tr>
<tr><th colspan="2">Standards and Related Background Information</th><th>Instructional Focus</th><th>Instructional Materials</th></tr>
<tr><td colspan="2">DCI(s)
PS3: Energy

Standard(s)
6.PS3.1 Analyze the properties and compare the sources of kinetic, elastic potential, gravitational potential, electric potential, chemical, and thermal energy.

6.PS3.3 Analyze and interpret data to show the relationship between kinetic energy and the mass of an object and its speed.

6.PS3.4 Conduct an investigation to demonstrate the way that heat (thermal energy) moves among objects through radiation, conduction, or convection.

Explanation(s)
<u>6.PS3.1</u> Students should develop an understanding of energy which has two components: energy</td><td>Learning Outcomes
• Define thermal energy.
• Differentiate between thermal energy and temperature.
• Define heat and calorie.
• Differentiate between heat and temperature.
• Differentiate between heat and thermal energy.
• Explain that adding heat to or removing heat from a system may result in a change of state.
• Describe and provide examples of conduction, conductor, insulator, convection, and radiation.

Phenomenon

Heat is the movement of thermal energy from a warmer object to a cooler object. Thermal energy is the sum of the kinetic energy and potential energy in a material.</td><td>Curricular Materials
HMH Tennessee Science TE, pp. 24-36
<u>Engage and Explore</u>
• Engage Your Brain #s 1 and 2, SE p. 31
• Active Reading #s 3 and 4, SE p. 31
<u>Explain</u>
Thermal Energy
• Thermal Energy in a Bottle Daily Demo, TE p. 40
• Active Reading #5, SE p. 32
• Apply #6, SE p. 33
• Temperature and Thermal Energy, TE p. 41
Heat
• We’re in Hot Water, TE p. 40
• Apply #7, SE p. 34
• Visualize It! #8, SE p. 35
• Active Reading #9, SE p. 35
Changes of State
• Heat Race Activity, TE p. 40</td></tr>
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<td>storage (6.PS3.1) and transformation (6.ps3.2). Energy can be possessed by an object or stored in fields. Objects can possess energy as kinetic (motion of objects), thermal (motion of particles), or chemical energy (energy stored in chemical bonds). Fields can possess energy based on the position of an object within the field. Gravitational fields store/release gravitational potential energy when an object changes position within the gravitational field. Electric fields store/release electric potential energy as charges change position within an electric field. Finally, forces which distort the shapes of objects store energy in the elastic/distorted object (elastic potential). For example, the elastic bands of a sling shot store energy when they are pulled back. Upon release, the elastic bands then do work on the object in the slingshot transferring energy away from the bands and giving kinetic energy to the projectile.

<u>6.PS3.3</u> Students should analyze data to see that kinetic energy is directly proportional to mass and to the square of velocity. Students can be provided data to carry out this analysis. Alternately, heavy objects can be dropped into beds of flour or soft material and comparisons of the indentions can be made. Doubling the mass and dropping from the same height will produce an indention with a volume twice as great. Dropping an object from a height twice as great leaves and indention with</td>
<td>Temperature represents the average kinetic energy in a material. This photo shows various forms of thermal energy transfers. For example, convection carries the flames and smoke from the fire upward. Air around the fire heats and rises. The ground under the fire will get hot, heated by conduction. Radiation from the fire heats the camper.</td>
<td>• Observing the Transfer of Energy Quick Lab, TE p. 40 (SEP: Analyzing and Interpreting Data, Engaging in Argument from Evidence)
• Think Outside the Book #10, SE p. 36
• Active Reading #11, SE p. 36
Methods of Thermal Energy Transfer
• Classify #12, SE p. 37
• Active Reading #13, SE p. 38
• Classify #14, SE p. 38
• Exploring Thermal Conductivity Quick Lab, TE p. 41 (SEP: Analyzing and Interpreting Data, Engaging in Argument from Evidence)
• Simple Heat Engine Quick Lab, TE p. 41 (SEP: Developing and Using Models)
<u>Extend</u>
Reinforce and Review
• Which Way Did the Energy Go? Activity, TE p. 44
• Visual Summary, SE p. 40
Going Further
• Why It Matters, SE p. 39
<u>Evaluate</u>
Formative Assessment
• Throughout TE
• Lesson Review, SE p. 41
Summative Assessment
• Thermal Energy and Its Transfer Alternative Assessment, TE p. 55
• Lesson Quiz</td>
</tr>
</table>

four times the volume. (Instruction of this standard can be limited to recognizing that as the speed of an object increases, the kinetic energy increases at a greater rate and describing qualitative changes to kinetic energy. Creating proportionalities, graphing linear/quadratic relationships and exponents all exceed sixth grade Tennessee math standards, but can be used for enrichment in with advanced students.) 6.PS3.4 In everyday language, "heat" is used to refer to thermal energy. Students should emphasize the difference between these two terms. Heating is a method by which energy can be transferred from one object to another. Thermal energy is the energy stored by the movement of particles and is measured using a thermometer. There are three specific means of heating: conduction, convection, and radiation. Radiation (light) can be seen as a form of heating, but is unique from conduction and convection, because it can transfer energy across empty space. Students can observe changes in thermal energy (by recording temperature) using any of the above methods of heating. **Misconception(s)** Clarify the difference between temperature and thermal energy by correctly defining the two terms. Temperature represents the average kinetic		**Additional Resources** • Heat STUDY JAMS! Video • Heat, Temperature, and Conduction Lesson • Cooking with the Sun - Creating a Solar Oven • Energy Skate Park Basics Energy Exploration • Atmospheric Process: Radiation Experiment • Save the Penguins Investigation • Pendulum Energy Simulation • 6.PS3.3 Student Activity and Teacher Guide • 6.PS3.4 Student Activity , Teacher Guide, and Heat Transfer Viewing Guide • Conduction, Convection, and Radiation Teacher Demonstrations

energy of the particles that make up a material. Thermal energy is the sum of the kinetic energy and the potential energy in the particle that make up a material. Explain to students that at the same temperature, some materials carry thermal energy away from your hand more quickly than other materials, and this makes them feel colder. Metals carry thermal energy away more quickly than wood does. Because of this, metals usually feel colder than wood even if they are the same temperature. Materials carry thermal energy away quickly are thermal conductors, and those that don't are thermal insulators. **Suggested Science and Engineering Practice(s)** Developing and Using Models 6.PS3.1 Students create models which are responsive and incorporate features that are not visible in the natural world, but have implications on the behavior of the modeled systems and can identify limitations of their models. Analyzing and Interpreting Data 6.PS3.3 Students should create and analyze graphical presentations of data to identify linear and non-linear relationships, consider statistical features within data and evaluate multiple data sets for a single phenomenon.		

Planning and carrying out controlled investigations 6.PS3.4 Students begin to investigate independently, select appropriate independent variables to explore a dependent variable and recognize the value of failure and revision in the experimental process. **Suggested Crosscutting Concept(s)** Energy and Matter 6.PS3.1 Students track energy changes through transformations in a system. Scale, Proportion, and Quantity 6.PS3.3 Students create proportional and algebraic relationships from graphical representations. Cause and Effect 6.PS3.4 Students begin to connect their explanations for cause and effect relationships to specific scientific theory.		

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<tr><th>Unit 1, Lesson 4</th><th>Lesson Length</th><th>Essential Question</th><th>Vocabulary</th></tr>
<tr><td>Effects of Energy Transfer</td><td>1.5 weeks</td><td>How does the use of energy resources affect the environment?</td><td>renewable resource, nonrenewable resource, fossil fuel</td></tr>
<tr><th colspan="2">Standards and Related Background Information</th><th>Instructional Focus</th><th>Instructional Materials</th></tr>
<tr><td colspan="2">DCI(s)
6.ESS3: Earth and Human Activity

Standard(s)
6.ESS3.1 Differentiate between renewable and nonrenewable resources by asking questions about their availability and sustainability.

6.ESS3.2 Investigate and compare existing and developing technologies that will utilize renewable and alternate energy sources.

6.ETS1.2 Design and test different solutions that impact energy transfer.

Explanation
<u>6.ESS3.1</u> In fourth grade, students were introduced to several specific examples of renewable and nonrenewable resources. Discussions included general descriptions of where resources were located on earth, how they are obtained, and the effects these processes have on the earth.</td><td>Learning Outcomes
• Describe the ways in which humans use energy.
• Compare and contrast renewable and nonrenewable resources.
• Explain how fossil fuels are formed and how they are extracted for human use.
• Describe consequences of continuing to use energy resources at the current rate.
• Identify ways that fossil fuels can be conserved.
• Describe the benefits and limitations of the following energy sources:
○ Solar
○ Hydroelectric
○ Geothermal
○ Nuclear
○ Wind
○ Biomass</td><td>Curricular Materials
HMH Tennessee Science TE, pp. 58-61
<u>Engage and Explore</u>
• Engage Your Brain #s 1 and 2, SE p. 51
• Active Reading #s 3 and 4, SE p. 51
<u>Explain</u>
Renewable and Nonrenewable Resources
• Active Reading #5, SE p. 52
• Visualize It! #6, SE p. 52
• Venn Diagram #7, SE p. 53
• Everyday Resources Daily Demo, TE p. 61
• Sustainable Resource Management Exploration Lab, TE p. 61 (SEP: Developing and Using Models, Analyzing and Interpreting Data)
Fossil Fuels
• Active Reading #8, SE p. 54
• Visualize It! #9, SE p. 54
• Visualize It! #10, SE p. 55
• Pros and Cons Activity, TE p. 60
• Time Machine Activity, TE p. 60
Alternative Energy Sources</td></tr>
</table>

Students should now develop a full, working distinction between these sets of resources. Renewable resources can be replenished during a human lifetime. However, non-renewable resources can be exhausted or, in the case of a living species, complete eliminated. Geologic processes which create some natural resources result in isolated pockets with large accumulations of a specific resource (e.g., oil deposits in the middle east, coal deposits in the western United States, gold deposits in California, the use of Tennessee waterways for hydroelectric power generation.) <u>6.ESS3.2</u> Utilization of natural resources involves weighing environmental, economic, and oftentimes political conversations. Environmental discussions should include models which help to predict effects and gains of using a natural resource on the environment. Economic considerations include the amount of energy which can be harvested for the cost. For example, the economy of installing residential photovoltaic systems depends on the availability of sunlight in a person's location or on their property. Political conversations are impacted by considering global distributions of energy sources. As technologies progress, energy harvesting becomes less expensive and more efficient such that conversations regarding the utilization of	**Phenomenon**  Carbon County Wyoming, known as American coal country has long been known for its extensive coal deposits. Because energy cannot be created there; electric energy used daily must be produced by transforming some other kind of energy.	• Active Reading #11, SE p. 56 • Think Outside the Book #12, SE p. 56 • Summarize #s 13 and 14, SE p. 57 • Inquiry #15, SE p. 58 • The Power of the Sun Activity, TE p. 60 • Water Power Activity, TE p. 60 • Modeling Renewable Energy Quick Lab, TE p. 61 (SEP: Using Mathematics and Computational Thinking, Developing and Using Models) • Designing a Vehicle Using Alternative Energy Quick Lab, TE p. 61 (SEP: Constructing Explanations and Designing Solutions, Engaging in Argument from Evidence) <u>Extend</u> Reinforce and Review • Visual Summary, SE p. 60 Going Further • History Connection, TE p. 64 • Why It Matters, SE p. 59 <u>Evaluate</u> Formative Assessment • Throughout TE • Lesson Review, SE p. 61 Summative Assessment • Our Energy Use Alternative Assessment, TE p. 65 • Lesson Quiz

renewable and alternate energy sources may shift over time. 6.ETS1.2 Even design solutions that meet criteria and constraints for a successful design may fail in production. The tests should be designed to expose failure in specific components of a device. The results of these tests can then be used to create a comprehensive solution. Design tasks might relate to selecting materials to minimize or maximize energy transfer into or out of a system by minimizing heat loss, or sound production or by maintaining initial kinetic energies. **Misconception(s)** Students may believe that switching from fossil fuels can be done quickly. Explain that the current state of energy technology makes electricity produced by using renewable resources cost more than electricity produced by using fossil fuels. **Suggested Science and Engineering Practice(s)** Obtaining, Evaluating, and Communicating Information 6.ESS3.1(Observe) Students can evaluate text, media, and visual displays of information with the intent of clarifying claims and reconciling explanations. Students can communicate scientific information in writing utilizing embedded tables, charts, figures, graphs.		• S.T.E.M. Engineering Design Process, SE p. 46-49 **Additional Resources** • 6.ESS3.1 Student Activity, Student Notes, Card Sort Images, and Teacher Guide

Engaging in Argument From Evidence 6.ESS3.2 Students critique and consider the degree to which competing arguments are supported by evidence. Planning and Carrying Out Controlled Investigations 6.EST1.2 Students can design tests which determine the effectiveness of a device under varying conditions. **Suggested Crosscutting Concept(s)** Energy and Matter 6.PS3.1, 6.PS3.2 Students track energy changes through transformations in a system. Systems and System Models 6.ESS3.1 Students evaluate the sub-systems that may make up a larger system.		